

Study of plastic pollution levels in the Changbai Mountain Area

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Abstract: Based on the current situation of environmental pollution in the Changbai Mountain Area, the maximum safe level of plastic in the Changbai Mountain Area is estimated with the help of environmental Kuznets curve, and suggestions are made to reduce the plastic pollution in the Changbai Mountain Area to make it reach the safe level.

Key Word: plastic pollution ; environmental Kuznets curve; ternary linear regression.

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I. Introduction

Changbai Mountain is located in Antu County, Yanbian Prefecture, Jilin Province and Fusong County, Baishan City, and is known as "the first peak on earth with thousands of years of snow". In recent years, Changbai Mountain has become a must-visit destination for many tourists. While the rapid rise of tourism has led to the rapid development of the local economy, many environmental pollution problems have also arisen. Among them, the problem of plastic pollution should be of wide concern to experts and scholars.

An article in Time magazine had pointed out that, as a result of the war, plastics had moved on to new uses and their suitability had once again been proven. The creation of new materials has helped to free people from the social and economic constraints caused by the scarcity of natural resources. For the Changbai Mountain region, the rapidly increasing number of tourists, the growing service sector and the endless industrial production have all contributed to a certain extent to the use of single-use plastic products, which in turn has had a serious impact on the local environment.

In 2017, Xu Dongyu and Ma Yunchi¹ analysed the environmental pollution problems in the Changbai Mountain region from four aspects in a paper on environmental pollution in tourism development in the Changbai Mountain region, and made recommendations for changing environmental pollution, such as clarifying development goals and environmental protection measures. 2019, Huang Lia et al² conducted an in-depth study on the development and protection of the Changbai Mountain region in a paper on the status of resource development and ecological environmental protection in the Changbai Mountain region. In an article on the current situation of development and ecological environmental protection, they conducted an in-depth study on the development and protection of the Changbai Mountain region, put forward the current problems including forest ecological functions, ecosystems and biological species, and then gave countermeasures such as strengthening ecological testing and making scientific research forecasts. In the same year, Wu Bing et al³, in an article on the discussion of ecological protection and restoration ideas in the Changbai Mountain area of Jilin Province, stressed the importance and urgency of implementing ecological protection in the Changbai Mountain area, as well as the general layout and key tasks of environmental protection. Inspired by the above literature, this paper will model the estimation of maximum safe levels of plastics in the Changbai Mountain region and make recommendations for reducing plastic pollution to achieve safe levels.

II. Environmental Status of Changbai Mountain

The Changbai Mountain region is the main distribution area of natural forests, which is connected to Heilongjiang Province in the north, Russia in the east and North Korea in the southeast across the Tumen and Yalu rivers. The total area is 1.08×10⁷ million hm², accounting for 57.4% of the total area of Jilin.[4]The ecological problems in the Changbai Mountains have become more and more serious due to inappropriate exploitation in recent years and the blind pursuit of economic benefits by workers at the expense of the ability of the Changbai Mountain ecosystem to repair itself. Coupled with the rapid rise of tourism in the Changbai Mountains, the constant influx of people, the expansion of industry and the development of transport and other industries, the local plastic pollution problem has become critical.

III. Modeling of plastic level estimation

An analysis of the literature shows that the level of local economic development and energy consumption are the main factors contributing to plastic pollution in the Changbaishan region.

For the Changbaishan region, the area where people gather for sexual activity is approximated as a circle with radius r . The area of the circle is the sum of the areas where people gather for sexual activity. Based on the topographic distribution of the Changbaishan region, it is considered as an outer circle with a radius of R . At this point, the area of the circle is the sum of the areas where people mainly discharge plastic waste.

For plastic pollution, the source of the pollution is located in the inner circle in the area where people gather for sexual activity, and the concentration of plastic pollutants decreases outwards in a gradient from the centre of the pollution to the outer circle. The part of the pollutant that spreads outwards from the inner circle can be approximated as the self-healing capacity of the Changbai Mountain ecosystem; for the pollutant that penetrates from the outer circle to the inner circle, it can be approximated as the local environment's own emissions.

Therefore, for year n , the plastic pollutants in the Changbai Mountain area are divided into domestic and industrial wastes.

For domestic waste, there is a per capita domestic waste emission formula

$$F_n = K_n * M_n \quad (1)$$

Where F_n is the per capita domestic waste emissions in year n , K_n is the emission factor in year n and M_n is the per capita use of plastic products in year n .

For industrial waste, the higher the level of energy consumption, the more industrial waste there is.

From the industrial waste discharge formula

$$S_n = Q_n * C_n \quad (2)$$

where S_n is the amount of industrial waste emitted in year n , Q_n is the amount of industrial product used in year n and C_n is the emission factor in year n .

Subsequently, applying the environmental Kuznets curve, a linear relationship between the per capita emissions of pollutants F_n and the household economic level y can be obtained

$$F_n = \alpha y \quad (3)$$

And there is also a linear relationship between the coefficient α itself and the household economic level y

$$\alpha = \beta_0 y - \beta_1 y^2 \quad (4)$$

Combining equations (3) and (4) gives

$$F_n = \beta_0 y - \beta_1 y^2 \quad (5)$$

It is assumed that the change in pollutant stock over time can be represented by the differential equation

$$\dot{A}_t = F_t - \alpha A_t \quad (6)$$

where F_t and A_t are the emissions and stocks of plastic pollutants at time t .

The average annual stock of plastic pollutants in the Changbai Mountains is $(A + \frac{F}{2})$, the pollutants that are

self-healed by the ecosystem is $\alpha (A + \frac{F}{2})$, and the annual increase in plastic pollutants is $F - \alpha (A + \frac{F}{2})$.

Let N_{TR} denote the total population and have the formula

$$F = F_n N_{TR} \quad (7)$$

The above equation is collapsed to give incremental plastic pollutants ΔA

$$\Delta A = (\beta_0 y - \beta_1 y^2) N_{TR} (1 - \frac{\alpha}{2}) - \alpha A \quad (8)$$

Further collation gives

$$\Delta A = -\alpha A + \beta_0 (1 - \frac{\alpha}{2}) Y - \beta_1 (1 - \frac{\alpha}{2}) \frac{Y^2}{N_{TR}} \quad (9)$$

where $Y = yN_{TR} = GDP$ is the annual gross product of the Changbai Mountain region.

For equation (9), let

$$\begin{cases} b_1 = -\alpha \\ b_2 = \beta_0(1 - \frac{\alpha}{2}) \\ b_3 = \beta_1(1 - \frac{\alpha}{2}) \\ z = \Delta A \\ x_1 = A \\ x_2 = Y \\ x_3 = \frac{Y^2}{N_{TR}} \end{cases} \quad (10)$$

The ternary linear equation can be obtained $z = b_1x_1 + b_2x_2 + b_3x_3$

A ternary linear regression of the equation yields the coordinates of the inflection point $(\frac{\beta_0}{2\beta_1}, \frac{\beta_0^2}{4\beta_1})$ of the

curve $F_n = \beta_0y - \beta_1y^2$

Therefore, the maximum safe level for plastics in the Changbai Mountain area should be

$$W = F_n + S_n = \frac{\beta_0^2}{4\beta_1} + S_n$$

Where the value of S_n is available from a query of local plant data in the Changbai Mountain area.

IV. Recommendations for reducing plastic pollution

A. Strengthening exchange and cooperation

The Changbai Mountain region should focus on strengthening cooperation and exchanging experiences with other ecologically sound regions while seeking economic development. The Li River Scenic Area in Guilin is the largest karst landscape scenic area in the world, and the local government adopted the Work Plan for Comprehensive Ecological and Environmental Improvement in the Li River Scenic Area in 2016 to strongly promote the prevention and control of local environmental pollution. In recent years, the environmental management of the scenic area has achieved remarkable results. From this perspective, the Changbaishan regional government should also study the region's management ideas in depth, further broaden the areas of cooperation and promote resource sharing in order to achieve win-win results.

B. Promoting industrial upgrading

To improve ecological construction, the Changbai Mountain region should increase its efforts to drain local industries, introduce advanced technology and speed up industrial upgrading to reduce plastic emission pollution. At the same time, the development of new plastic substitutes should be accelerated. Through analysis of the literature, it can be found that natural fibres are more commonly used plastic substitutes, such as environmentally friendly shopping bags and environmentally friendly paper. However, natural fibre materials are expensive and their applicability as a plastic alternative is not high. Therefore, finding new materials is a challenge for companies. Only by actively seeking alternatives to plastics while accelerating industrial upgrading can the economic development model move a step further from a black development model to a green development model.

C. Implementation of plastic restriction

Proper implementation of plastic restrictions in the Changbai Mountain region can save energy to a certain extent. The number of plastic bags consumed globally each year is also astronomical, consuming a large amount of precious petroleum resources. Appropriate implementation of plastic restrictions could go a long way to saving oil resources and also reduce the pollution of the local environment from plastic waste. At the same

time, plastic restrictions can also play a significant role in fostering awareness of environmental protection, thus helping to achieve sustainable development.

V. Conclusion

Green water and green mountains are the silver mountain of gold. This paper uses the environmental Kuznets curve to study the level of plastic pollution in the Changbaishan region. By establishing a model to estimate the maximum safe level of plastic in the Changbaishan region and making recommendations to reduce plastic pollution, it can further promote the implementation of environmental protection projects in the Changbaishan region and contribute to the cause of sustainable development.

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